METHOD AND APPARATUS FOR WIDE AREA MULTI-BODY 6D POSE TRACKING SYSTEM

[0001] This application claims the benefit of U.S. Provisional Application No. 62/547,238, filed Aug. 18, 2017, the disclosure of which is herein incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to tracking position and orientation of objects within a defined space, and more particularly to wide area six-dimensional (6D) pose tracking of objects such as ultrasound probes and medical devices.

[0003] Pose tracking refers to tracking the position and orientation measurements of rigid bodies that move in a defined space. The total number of measurements is six, which includes three positional and three orientation values in three-dimensional (3D) space. Tracking the position and orientation of objects within a large area is required in a variety of applications from medical interventional navigation to gaming.

BRIEF SUMMARY OF THE INVENTION

[0004] The present invention provides an apparatus and method for tracking a position and orientation of target objects over a wide area.

[0005] In an embodiment of the present invention, an apparatus for tracking a position and orientation in three-dimensional space of one or more objects comprises: one or more tracked sensor units, each tracked sensor unit connected with a respective one of the one or more objects and comprising one or more light sources and an inertial measurement unit; one or more position sensitive detector tracking devices, each position sensitive detector tracking device comprising a plurality of position sensitive detector sensors combined with optical lenses that focus light from a field of view onto each position sensitive detector sensor; and a processing unit configured to calculate the position and orientation of each of the one or more objects in three-dimensional space from output of the inertial measurement unit of the respective tracked sensor unit and output of the one or more position sensitive detector tracking devices in response to light emitted from the one or more light sources of the respective tracked sensor unit.

[0006] In an embodiment, in response to light emitted from a light source of a tracked sensor unit being focused onto each of the plurality of position sensitive detector sensors of a position sensitive detector tracking device, each of the plurality of position sensitive detectors measures a 2D location of the light source of the tracked sensor unit with respect to that position sensitive detector, and the processing unit is configured to triangulate a 3D position of the light source of the tracked sensor based on the 2D locations measured by the plurality of position sensitive detectors.

[0007] In an embodiment, each position sensitive detector tracking device further comprises a local inertial measurement unit, and the processing unit is configured to calculate a 3D orientation of each of the one or more objects with respect to each position sensitive detector tracking unit based on orientation measurements from the inertial measurement unit of the respective tracked measurement unit and orientation measurements from the local inertial measurement unit of the position sensitive detector tracking device.

[0008] In an embodiment, the one or more light sources of each tracked sensor unit comprise one or more light emitting diodes.

[0009] In an embodiment, the one or more light sources of each tracked sensor unit comprises a plurality of light emitting diodes arranged around an axis of the respective object to which the tracker sensor unit is connected.

[0010] In an embodiment, each tracked sensor unit further comprises a respective processing unit configured to control activation of the one or more light sources and to transmit orientations measurements output by the inertial measurement unit to the processing unit that calculates the position and orientation of the one or more objects.

[0011] In an embodiment, the processing unit comprises a respective processing unit embedded in each of the one or more position sensitive detector tracking devices, wherein each respective processing unit embedded in a position sensitive detector tracking device is configured to calculate the position and orientation of each of the one or more objects in three-dimensional space with respect to that position sensitive detector tracking device from the output of the inertial measurement unit of each tracked sensor unit and output of the plurality of position sensitive detector sensors in response to light emitted from the one or more light sources of each tracked sensor unit.

[0012] In an embodiment, the inertial measurement unit comprises one or more of an accelerometer, a gyroscope, or a magnetometer.

[0013] In an embodiment, at least one of the one or more objects is a handheld ultrasound transducer, the one or more light sources of the tracked sensor device connected the handheld ultrasound transducer comprises a plurality of light emitting diodes arranged in a pattern around the handheld ultrasound transducer, and the one or more position sensitive detector tracking devices each comprise optical lenses of a fixed focal length and a filter configured to isolate information from a range of frequencies of the light emitting diodes.

[0014] In an embodiment, the handheld ultrasound transducer comprises a laparoscope ultrasound transducer, and wherein a first set of inertial measurement units are positioned in a first portion of the laparoscope with an ultrasound array, the first portion being rotatable relative to a fixed second portion of the laparoscope, and a second set of inertial measurement units are positioned on the fixed second portion along with the plurality of light emitting diodes.

[0015] In an embodiment, at least one of the one or more objects is a medical instrument, the one or more light sources of the tracked sensor device connected to the medical instrument comprises a plurality of light emitting diodes arranged in a pattern around the medical instrument, and with the one or more position sensitive detector tracking devices each comprise an optical lenses of a fixed focal length and a filter configured to isolate information from a range of frequencies of the light emitting diodes.

[0016] In an embodiment, the medical instrument comprises a first portion that is rotatable or articulated relative to a fixed second portion of the instrument, and wherein the tracked sensor device connected to the medical instrument comprises a first set of inertial measurement units positioned in the first portion of the medical instrument and a second set